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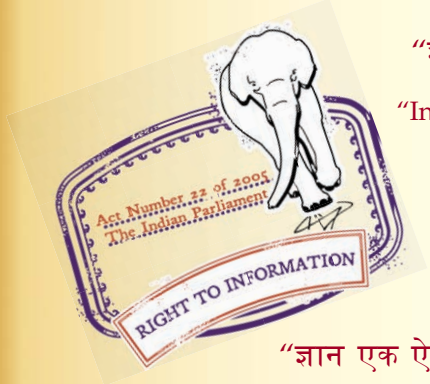

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Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS : 5922 - 1970

Indian Standard

QUALIFYING TESTS FOR WELDERS ENGAGED IN AIRCRAFT WELDING

UDC 621·791·753—05 : 377·127·6 : [629·13]

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 1

April 1971

Indian Standard

QUALIFYING TESTS FOR WELDERS ENGAGED IN AIRCRAFT WELDING

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Indian Standard

QUALIFYING TESTS FOR WELDERS ENGAGED IN AIRCRAFT WELDING

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 December 1970, after the draft finalized by the Welding General Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 Since the formulation of IS : 1181-1967*, need has been felt for standards covering qualifying tests for welders engaged in special jobs. This standard, the first in the series, specifies qualifying tests for gas and arc welders engaged in welding aircraft components.

0.3 This standard keeps in view the practices prevailing in the country in the field. Assistance has been derived from the following publications:

UNITED KINGDOM. MINISTRY OF TECHNOLOGY, D.G.Q.A. Inspection Instruction-Welding, Av. P. 84 D. 505 Issue 1 (formerly Av. P. 4089 D. 443 and 464), London.

UNITED KINGDOM. Civil Aircraft Inspection Procedures. Basic General Workshop Processes. Oxy-Acetylene Welding. Air Registration Board, London.

0.4 While the parent metal for conducting the qualifying tests specified in this standard shall be as specified by the certifying authorities, the material commonly used in the aircraft industry and conforming to the specifications issued by the following organizations is listed in Appendix A:

a) Indian Standards Institution

b) British Standards Institution, London

c) Directorate of Technical Development, Ministry of Aviation, UK

d) Society of Automotive Engineers, USA

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance

*Qualifying tests for metal-arc welders (engaged in welding structures other than pipes) (*first revision*).

with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard lays down the qualifying tests for welders engaged in aircraft welding by oxy-acetylene, inert gas and metal arc processes.

1.2 The tests specified in this standard cover welding in the following groups of material:

Group 1 Aluminium alloys,
Group 2 Magnesium alloys,
Group 3 Carbon steels,
Group 4 Alloy steel,
Group 5 Corrosion and heat resistant steels,
Group 6 Nickel base alloys,
Group 7 Titanium alloys, and
Group 8 Alloys not covered in groups mentioned above, such as copper base alloys.

2. TERMINOLOGY

2.1 For purposes of this standard, the definitions given in IS : 812-1957† shall apply.

3. SYMBOLS

3.1 For the purpose of this standard, the symbols used shall have the meanings assigned to them in IS : 813-1956‡.

4. MATERIAL

4.1 **Parent Metal** — The parent metal used in the preparation of test specimen shall be as decided by the approving authority.

4.2 **Welding Rods and Electrodes** — Welding rods and electrodes used shall conform to the relevant Indian Standard specifications, where

*Rules for rounding off numerical values (*revised*).
†Glossary of terms relating to welding and cutting of metals.
‡Scheme of symbols for welding.

available. In the absence of an Indian Standard these shall be as specified by the approving authority.

5. CERTIFICATION OF WELDERS

5.1 Each welder shall be certified by the competent authority. The grant of approval shall be given for the following:

a) Material groups specified in **1.2**;

b) Jointing process:

1) Gas welding — oxy-acetylene,

2) Arc welding — inert gas tungsten arc and gas metal arc; and

c) Class of work:

1) Tubular structures, components and sheet metal work, including structures, frames, trusses, engine mountings, castings, forgings, chars, etc; and

2) Sheet metal work only — tanks, cowls, manifolds, plate fittings, jet engine tail pipes; etc.

5.1.1 Before a welder is prepared to undertake welding of aircraft parts by gas or arc welding processes the evidence of his ability to perform such work should be available. Such evidence should be in the form of a satisfactory report issued by an approved test laboratory. The report should be based on the assessment of test welds made in accordance with **7** and **8**.

6. VALIDITY OF THE CERTIFICATE

6.1 The approval issued to a welder on the satisfactory test report shall remain valid for a period not exceeding six months.

6.2 Extension of Welder's Certificate — An applicant seeking issue, extension or renewal of welder's certificate shall comply with the requirements specified in Table 1.

6.2.1 To verify the operator's continued skill, check tests shall be made at periodic intervals to be determined by the approving authority. These checks shall be made on the samples selected from the production work without prior notice or on test piece as given in **7**.

6.2.2 The component authority may, at any time, select samples from an approved welder's work for non-destructive examination.

6.3 Requalification of the Welder

6.3.1 Requalification of the welder shall be required where:

a) a welder is changed from one class of work to another,

b) there is a change in welding process from gas to arc or *vice versa*, and

TABLE 1 TESTS FOR INITIAL APPROVAL AND EXTENSION OF WELDER'S CERTIFICATE

(*Clauses* 6.2 *and* 7.2.1)

	Material Group	Weld Test Pieces to be Fabricated		Tests Required
		Oxy-acetylene	Arc Welding (Inert-gas metal arc and inert-gas tungsten arc)	
Initial approval	1 and 2	Fig. 1	Fig. 1	Tensile, Bend and Microscopic
Periodic check	1 and 2	Fig. 1	Fig. 1	Tensile, Bend and Microscopic
Initial approval	3,4,5,6,7 and 8	Fig. 1	Fig. 1	Tensile, Bend and Microscopic
		Fig. 2	Fig. 2	Microscopic
		*Fig. 3, 4 or 5	Fig. 3, 4 or 5	Tensile and Microscopic
Periodic check	3,4,5,6,7 and 8	Fig. 1	Fig. 1	Tensile, Bend and Microscopic
		Fig. 2	Fig. 2	Microscopic
		†Fig. 3, 4 or 5	Fig. 3	Tensile

*The test specimen should be chosen from among Fig. 3, 4 or 5 so that it is representative of the class of work, that is from 7 dimensions of the work upon which the welder is to be employed.

†The I-shaped assembly required for tests or test shown in Fig. 3, 4 or 5 omitting the diagonal tube.

c) the welder is not engaged in any particular type of work or material for a period more than two months.

7. QUALIFICATION TESTS

7.1 Initial Qualification Test

7.1.1 Five types of test specimens are shown in Fig. 1 to 5. Each welder shall make one or more of these test specimens as required by the approving authority. In deciding the type of test specimens required, their material etc, consideration should be given to the class of work on which the candidate is employed.

7.1.2 The proficiency in welding one group of material does not verify proficiency in welding material in any of the other groups.

7.1.3 All the test specimens shall be made under the supervision of an inspector. If the welder is dissatisfied with the quality of his work on any test specimen, he may be allowed at the discretion of the inspector to

prepare more specimens but not more than three. If any of the weld specimens submitted by a welder is found to be unsatisfactory, he may be allowed at a later date, but not earlier than one month, to submit a fresh set of specimens and there shall be some evidence that the welder had an opportunity in the meantime, of acquiring additional experience in the particular job.

7.2 Periodic Check Tests

7.2.1 These tests shall comprise preparation and testing specimens shown in Fig. 1 to 5. Details of the type of test specimens required are given in Table 1.

7.2.2 The maximum period between check examinations shall be six months. More frequent examinations may be called for by the competent authority in respect of corrosion resisting and special alloy steels. If the test results are unsatisfactory in the first check examination, another check examination shall be repeated immediately and the specimens be sent to approved test laboratory. During the period between any check test which proved unsatisfactory and the results of the next check test the welder shall not be permitted to weld in that particular material group any stressed parts which are essential to the airworthiness of an aircraft. In case the check test results are again unsatisfactory the welder's approval shall be suspended. The welder should be allowed to submit fresh samples for initial approval only after satisfactory proof of his further training or experience to the satisfaction of the inspector.

7.2.2.1 Some casts of steel appear to be particularly prone to frothing during welding. In such instances where the defects are not entirely the fault of the welder, the requirements of **7.2.2** are not to be enforced and the welder is to be permitted to submit further samples without delay.

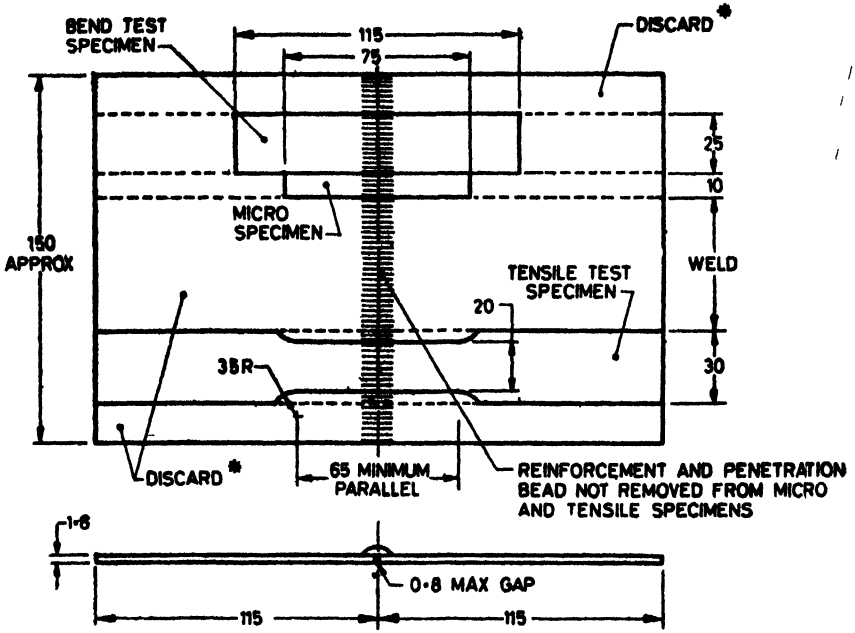
7.2.3 The competent authority may also select periodically samples from the welder's regular production work, if desired, and send the same for examination to an approved testing laboratory.

7.2.4 If the check test report on a welder's production work proves adverse, an immediate further check test is to be carried out. If the further check also proves adverse, the welder shall not be permitted to weld any further stressed parts until he or she has prepared a further set of initial competency test samples to the satisfaction of the inspection authority.

8. PREPARATION OF TEST SPECIMENS AND TESTING

8.1 Preparation of Test Specimens

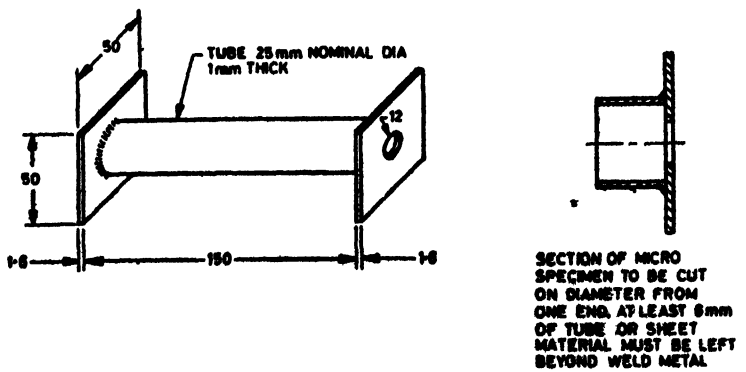
8.1.1 The test specimens shall be prepared in consultation with the approving authority and tested in the manners described in **8.2** to **8.6** and shall satisfy the requirements for qualifying the welder for that particular job.



*Sufficient discard to ensure that beginning and end of run is not included in test specimen.

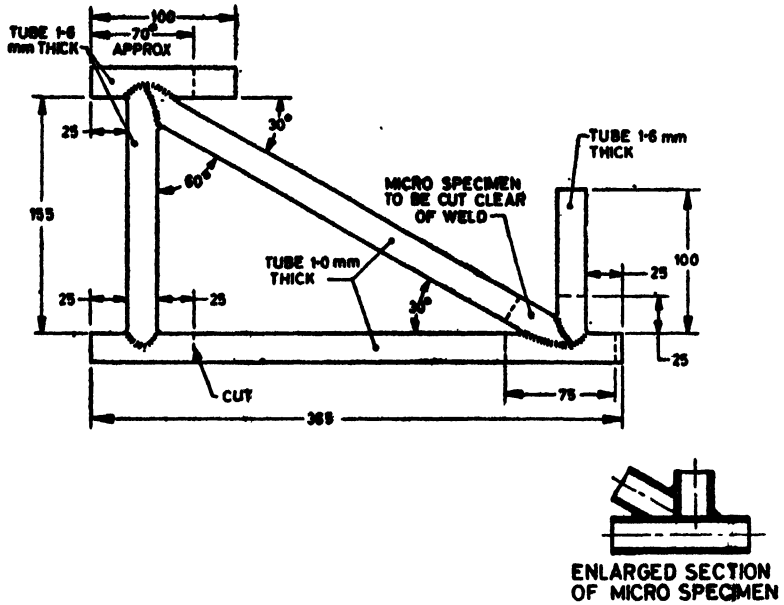
All dimensions in millimetres.

FIG. 1 SHEET TO SHEET BUTT WELD



All dimensions in millimetres.

FIG. 2 TUBE TO SHEET WELD

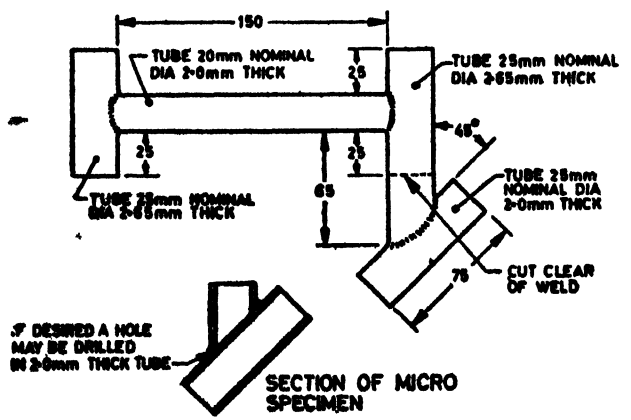


NOTE — Dimensions to be regarded as approximate.

*Minimum length which will avoid cutting into weld metal.

All dimensions in millimetres.

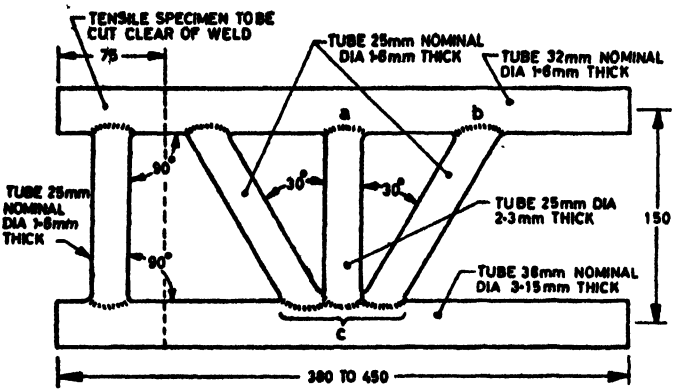
FIG. 3 TUBE TO TUBE WELD USING TUBES 20 mm NOMINAL DIAMETER



NOTE — Dimensions to be regarded as approximate.

All dimensions in millimetres.

FIG. 4 TUBE TO TUBE WELD



NOTE 1 — Dimensions to be regarded as approximate.

NOTE 2 — Welds a, b, c to be sectioned longitudinally and micro-examined.

All dimensions in millimetres.

FIG. 5 COMPLEX TUBE TO TUBE WELD

8.1.2 The test pieces in magnesium alloys shall not be sheared from the sample as this method is found to cause cracking. The samples shall be sawn and the material up to a distance of 1·5 mm from the edge should be removed by filing.

8.1.3 Heat Treatment — When required the specimens shall be suitably heat treated.

8.2 Test No. 1 — Butt Welds in Sheets 1·6 mm Thick

8.2.1 The parent metal shall be as specified for the application.

8.2.2 *Assembly for Welding* — Test specimen shall conform to the requirements shown in Fig. 1. The joint preparation shall be square with a maximum root gap of 0·8 mm. Tack welds shall be on the side to be welded and in the line of the weld. No other method of restraint shall be used. Distortion or misalignment caused by tacking may be corrected before the test weld is deposited. The test piece shall be supported in such a manner that contact with the bench or other material does not provide a backing bar for the joint.

8.2.3 The size and type of electrodes used and their classification shall be recorded.

NOTE — A sealing run on the reverse side is not permitted so that the degree of root penetration may be subsequently examined.

8.2.4 *Assessment*

8.2.4.1 *Visual examination* — The weld shall be visually examined for the following:

a) *Shape of profile* — The profile of the weld shall be uniform, slightly convex and free from overlap at the toes of the weld. The amount of reinforcement shall not exceed 1·5 mm.

b) *Uniformity of surface* — The weld face shall be uniform in appearance throughout its length.

c) *Degree of undercut* — The welded joint shall be free from undercut, but slight intermittent occurrences may be disregarded.

d) *Smoothness of joints where welding is recommended* — The joints in the weld run shall be smooth and shall show no pronounced hump or crater in the weld surface.

e) *Freedom from surface defects* — The surface of the weld shall be free from porosity, cavities and trapped slag.

f) *Penetration bead* — A slight penetration bead should be present, but slight intermittent occurrences of the lack of penetration bead may be disregarded.

8.2.4.2 *Tensile test* — One tensile test specimen shall be cut from the test piece as indicated in Fig. 1. The test piece shall be pulled in the usual manner. The ultimate stress and the position of the break are to be recorded. A specimen is to be considered satisfactory only if its ultimate strength reaches the specified value. The ultimate strength values for the commonly used material in the aircraft industry are given in Appendix A.

8.2.4.3 *Bend test* — The test specimen shall be cut as shown in Fig. 1. The root side of the specimen (that is, the base of the V) shall be dressed by filing or grinding so that the root of the weld is flush with the parent metal. The edges of the test specimen in the vicinity of weld shall be given a reasonable radius. The test specimen shall be bent so that the weld lies along the central line of the former. The angle of the bend and radius of the former in terms of thickness of the material for commonly used material in the aircraft industry are given in Table 2. The test shall be considered satisfactory if the test specimen withstands the bending without showing cracks visible to the naked eye.

In the case of corrosion resistant steels the bend test specimen shall be tested for intercrystalline corrosion before bending. The specimen shall be heated in accordance with the requirements of the material specification in a furnace and cooled in air. It shall then be immersed in a boiling solution in Soxhlet apparatus for 72 hours. The solution shall contain 111 g of copper sulphate crystals ($CuSO_4 . 5H_2O$) and 98 g of concentrated sulphuric acid (H_2SO_4) of specific gravity 1·84, and the volume made up to one litre with distilled water.

TABLE 2 STRENGTH REQUIREMENTS OF AIRCRAFT MATERIALS

(*Clauses* 8.2.4.3 *and* A-2)

MATERIAL	SPECIFICATION	ULTIMATE TENSILE STRENGTH IN THE AS WELDED CONDITION Kgf/mm², *Min*	BEND TEST	
			Angle of Bend Degrees	Radius of Former
(1)	(2)	(3)	(4)	(5)
Group 1 Aluminium alloys	L 16	7·9	180	2*t*
	L 17	7·9	180	2*t*
	L 56	14	—	—
	L 59	9·5	180	2*t*
	L 81	16	180	2*t*
	L 82	22	180	2*t*
	L 503	28	180	2*t*
	L 504	22	—	—
	L 509	11	180	2*t*
Group 2 Magnesium alloys	DTD 118	12·5	180	10*t*
	DTD 348	14	—	—
	DTD 626	17	180	10*t*
	DTD 5021	17	—	—
Group 3 Carbon steels	S 21	39·5	180	2*t*
	S 92	50·5	180	2*t*
	S 510	41	180	2*t*
	S 511	28	180	2*t*
	S 6	31·5	—	—
	S 26	31·5	—	—
	S 35	39·5	—	—
	S 45	39·5	—	—
	S 54	34	—	—
Group 4 Alloy steels	S 514	47	180	2*t*
	S 515	47	180	2*t*
	S 518	55	180	2*t*
	S 519	55	180	2*t*
	S 534	55	180	2*t*
	S 535	79	180	2*t*
	T 53	55	—	—
	T 56	39·5	—	—
	T 59	63	—	—
	T 60	71	—	—
	DTD 740	60	—	—
	DTD 5062	60	180	3*t*
	DTD 5112	83·5	—	—
	DTD 5132	118·5	—	—
	DTD 5142	118·5	—	—
	SAE 4130 sheets	—	180	3*t*
	SAE 4130 tubes	—	—	—

(*Continued*)

TABLE 2 STRENGTH REQUIREMENTS OF AIRCRAFT MATERIALS — *Contd*

Material	Specification	Minimum Tensile Strength in the as Welded Condition Kgf/mm², *Min*	Bend Test	
			Angle of Bend Degrees	Radius of Former
(1)	(2)	(3)	(4)	(5)
Group 5 Corrosion & heat resistant steels	S 522	55	90	3*t**
	S 523	55	90	3*t**
	S 524 & 525	55	90	3*t**
	S 526 & 527	55	90	3*t**
	T 55	47	—	—
	T 58	47	—	—
	T 61	47	—	—
	DTD 712	47	90	3*t**
Group 6 Nickel alloys	DTD 328	43	180	2*t*
	DTD 703	63	180	2*t*
	DTD 5037	112	180	4*t*†
	DTD 5047	76	180	4*t*†
	DTD 5057	98	180	4*t*†
Group 7 Titanium alloys	DTD 5023	39·5	180	4*t*†
	DTD 5033	39·5	180	4*t*†
Group 8 Copper base alloys	DTD 283	32	180	2*t*
	British Standard 265	28	180	2*t*
	British Standard 266	28	180	2*t*

t = thickness of material.

*Test pieces to be given pickling as specified in the specification for the parent metal for inter crystalline corrosion.

†To be bent after appropriate post weld heat treatment, that is, ageing, of stress relief and ageing as appropriate.

The bend test shall be carried out with a bad support or rubber backing only for materials of Groups 2, 4 and 7 only.

8.2.4.4 *Microscopic examination* — One micro-examination specimen shall be cut from the test piece as indicated in Fig. 1. The surface of the specimen cut in the longitudinal direction of the sample at right angles to the surface of the weld shall be prepared, and examined microscopically (*see* Appendix B). In steels the section so examined shall be free from excessive carburization or decarburization while with all other metals and alloys the surface shall be free from cracks, excessive cavitation and oxide inclusions. The surface shall show satisfactory penetration. After polishing the sample shall be examined microscopically first at a magnification of '× 10' and then at a higher magnification of '× 100'.

8.3 Test No. 2 — Welds Between Tube and Sheet — The specimen shall be prepared as shown in Fig. 2.

8.3.1 *Assessment*

8.3.1.1 *Visual examination* — The weld shall be assessed by visual examination for the following:

a) *Dimensions of weld deposits* — The test weld shall be of a size between 1·5 and 3·0 mm leg length deposited in a single run.

b) *Shape of profile* — The contour of the weld may be flat, slightly convex or slightly concave depending on the choice of the electrode and position of welding.

c) *Uniformity of surface* — The weld face shall be uniform in appearance throughout its length.

d) *Degree of undercut* — The welded joint shall be free from undercut, but slight intermittent occurrences may be disregarded.

e) *Smoothness of joints* — The joints in the weld run shall be smooth and shall show no pronounced hump or crater in the weld surface.

f) *Freedom from surface defects* — The surface of the weld shall be free from porosity, cavities and trapped slag.

NOTE — For guidance in the visual examination of welds, *see* 14.1 of IS : 817-1966*.

8.3.1.2 *Microscopic examination* — The section when cut, prepared and examined under microscope shall show adequate penetration and freedom from excessive carburization or decarburization, cracks, excessive cavitation and oxide inclusions either in the weld metal or at the junction between base metal and the weld metal.

8.4 Test No. 3 — Welds Between Tubes of Diameter 19 mm — The test specimen shall be prepared as shown in Fig. 3 and the following tests shall be conducted on the specimens:

8.4.1 *Assessment*

8.4.1.1 *Visual examination* — The weld shall be assessed by visual examination for the following:

a) *Dimensions of weld deposit* — The test weld shall be of a size between 1·5 and 3·0 mm leg length deposited in a single run.

b) *Shape of profile* — The contour of the weld may be flat, slightly convex or slightly concave depending on the choice of the electrode and position of welding.

*Code of practice for training and testing of metal arc welders (*revised*).

c) *Uniformity of surface* — The weld face shall be uniform in appearance throughout its length.

d) *Degree of undercut* — The welded joint shall be free from undercut, but slight intermittent occurrences may be disregarded.

e) *Smoothness of joints* — The joints in the weld run shall be smooth and shall show no pronounced hump or crater in the weld surface.

f) *Freedom from surface defects* — The surface of the weld shall be free from porosity, cavities and trapped slag.

NOTE — For guidance in the visual examination of welds, *see* 14.1 of IS : 817-1966*.

8.4.1.2 *Tensile test* — The left-hand portion of the specimen shown in Fig. 3 shall be tested in a tensile testing machine fitted with suitable shackles and pins, the latter being passed through the upper and lower cross tubes of the specimen. The thickness of the connecting tube shall be checked after completion of the test. The weld is considered unsatisfactory if it fails peeling away the weld even if it meets the strength requirements after welding.

8.4.1.3 *Micro-examination* — The right-hand portion of the specimen shall be cut as indicated in Fig. 3, etched and examined microscopically. The section shall show adequate penetration, free from cracks, excessive carburization or dicarburization, excessive oxide inclusions and cavities either in the weld metal or at the junction between the base metal and the weld metal.

8.5 Test No. 4 — Alternate Test of Welds Between Tubes of Thickness 19 mm — The test specimens shall be prepared as shown in Fig. 4.

8.5.1 *Assessment*

8.5.1.1 *Visual examination* — The weld shall be assessed by visual examination of the following:

a) *Dimensions of weld deposits* — The test weld shall be of a size between 1·5 and 3·0 mm leg length deposited in a single run.

b) *Shape of profile* — The coutour of the weld may be flat or slightly concave depending on the choice of the electrode and position of welding.

c) *Uniformity of surface* — The weld face shall be uniform in appearance throughout its length.

d) *Degree of undercut* — The welded joints shall be free from undercut, but slight intermittent occurrences may be disregarded.

*Code of practice for training and testing of metal arc welders (*revised*).

e) *Smoothness of joints* — The joints in the weld run shall be smooth and shall show no pronounced hump or crater in the weld surface.

f) *Freedom from surface defects* — The surface of the weld shall be free from porosity, cavities and trapped slag.

NOTE — For guidance in the visual examination of welds, *see* **14.1** of IS : 817-1966*.

8.5.1.2 *Tensile test* — The specimen shall be tested in a tensile testing machine fitted with suitable shackles and pins in the manner similar to that laid down in **8.4.1.2.** Where the specimen fails by the weld metal peeling away from the surface of one of the component parts, the weld shall be considered unsatisfactory, even though the stipulated ultimate stress may have been reached.

8.5.1.3 *Micro-examination* — The right-hand portion of the specimen shall be cut as indicated in Fig. 4 and examined as described in **8.4.1.3.**

8.6 Test No. 5 — Complex Tube to Tube Weld — The test specimen shall be prepared as shown in Fig. 5 and the following tests conducted:

8.6.1 *Assessment*

8.6.1.1 *Visual examination* — The weld shall be assessed by visual examination for the following:

a) *Dimension of weld deposit* — The test weld shall be of a size between 1·5 and 3·0 mm leg length deposited in a single run.

b) *Shape of profile* — The contour of the weld may be flat, or slightly convex or slightly concave depending on the choice of the electrode position of welding.

c) *Uniformity of surface* — The weld face shall be uniform in appearance throughout its length.

d) *Degree of undercut* — The welded joint shall be free from undercut, but slight intermittent occurrences may be disregarded.

e) *Smoothness of joints* — The joint in the weld run shall be smooth and shall show no pronounced hump or crater in the weld surface.

f) *Freedom from surface defects* — The surface of the weld shall be free from porosity, cavities and trapped slag.

NOTE — For guidance in the visual examination of welds, *see* **14.1** of IS : 817-1966*.

8.6.1.2 *Tensile test* — The left-hand portion of the section shall be cut and tested in a tensile testing machine fitted with suitable shackles and pins in a manner described in **8.4.1.2.**

8.6.1.3 *Micro-examination* — The welds indicated in Fig. 5 shall be cut, etched and subjected to micro-examination as described in **8.4.1.3.**

*Code of practice for training and testing of metal arc welders (*revised*).

APPENDIX A

(*Clauses* 0.4 *and* 8.2.4.2)

MATERIAL COMMONLY USED IN THE AIRCRAFT INDUSTRY

A-1. The material commonly used in the country in the aircraft industry conform to the following specifications:

a) **Indian Standards**

IS : 23-1965 Specification for primary (virgin) aluminium notched bars and ingots for remelting for aircraft purposes (*second revision*)

IS : 202-1966 Specification for aluminium casting alloy ingots and castings for aircraft purposes (*second revision*)

IS : 3435-1968 Specification for 99 percent secondary aluminium notched bars and ingots for remelting for aircraft purposes

IS : 3436-1966 Specification for aluminium-clad aluminium alloy sheet, strip and coil for aircraft purposes

b) **British Standards**

1) *Aluminium Alloys*

4 L 16 99 percent aluminium sheets (half hard)

4 L 17 99 percent aluminium sheets (soft)

2 L 56 Aluminium — 2½ percent magnesium alloy tubes (soft tested hydraulically)

2 L 59 Aluminium-manganese alloy sheets and strips (three-quarter hard)

L 81 Aluminium 2½ percent magnesium alloy sheets and strips (half hard) (replacing DTD 606 A)

L 82 Aluminium 3½ percent magnesium alloy sheets and strips (soft) (replacing DTD 180 C)

2) *Carbon Steels*

5 S 21 '20' Carbon steel (suitable for welding)

2 S 92 Carbon-manganese steel (suitable for welding)

S 5 10 28 ton carbon steel sheets and strips (suitable for welding) (Replaces 3 S 3)

S 5 11 Deep drawing carbon steel sheets and strips (suitable for welding) (Replaces S 84)

2 T 6 30-ton mild steel tubes (suitable for welding)

4 T 26 20-ton steel tubes (suitable for welding)

3 T 35 35-ton steel tubes (suitable for welding)

3 T 45 45-ton steel tubes (suitable for welding)

T 54 35-ton steel tubes (suitable for welding)

3) *Alloy Steel*

S 514 50 ton carbon-manganese steel sheets and strips (40 ton 0·1 percent proof stress) (suitable for welding) (Replaces DTD 124 A)

S 515 30 ton carbon-manganese steel sheets and strips (softened) (suitable for welding)

S 518 50 ton chromium-molybdenum steel sheets and strips (40 ton 0·1 percent proof stress) (suitable for welding)

S 519 75 ton chromium-molybdenum steel sheets and strips (65 ton 0·1 percent proof stress) (suitable for welding)

S 522 23/14 chromium-nickel steel sheets and strips (heat-resisting)

S 523 23/18 chromium-nickel steel sheets and strips (heat-resisting)

T-53 45-ton chrome-molybdenum steel tubes (suitable for welding)

T-53 35-ton chrome nickel non-corrodible steel tubes (suitable for pipe lines)

T-56 35-ton chrome-molybdenum steel tubes (suitable for welding)

T-58 50-ton chromium nickel non-corrodible steel tubes

T-60 75-ton chrome-molybdenum steel tubes (suitable for welding)

T-61 Chromium nickel heat resisting steel tubes (suitable for welding)

4) *Copper Alloys*

BS 265 : 1963 Cold rolled brass sheet, strip and foil, common brass

BS 266 : 1963 Cold rolled brass sheet, strip and foil, 2/1 brass

c) **Directorate of Technical Development, UK**

1) *Magnesium Alloys*

DTD 118 B Magnesium-1½ percent manganese alloy sheets and strips

DTD 348 A Magnesium aluminium-zinc alloy tubes

DTD 626 B Magnesium-zinc-zirconium alloy sheets (zinc 3·0, zirconium 0·7)

DTD 5021 Magnesium-zinc zirconium alloy tubes (suitable for welding by inert gas shielded arc techniques) (zinc 1·3, zirconium 0·7)

2) *Alloy Steels*

DTD 712 A Deep drawing chromium nickel steel sheets and strips (corrosion resisting)

DTD 740 40 percent molybdenum boron steel tubes (suitable for welding)

DTD 5062 40 percent molybdenum boron steel sheets and strips (suitable for welding)

DTD 5112 80 ton one percent chromium, molybdenum steel sheets (suitable for welding by specialized process)

DTD 5132 80 ton one percent chromium molybdenum steel tubes (suitable for welding by specialized process)

DTD 5142 80 ton one percent chromium molybdenum steel tubes (hot rolled) (suitable for welding by specialized process)

3) *Nickel Alloys*

DTD 328 Nickel-chromium iron alloy sheets and strips

DTD 703 B Nickel-chromium heat resisting alloy sheets and strips (cold rolled and softened)

DTD 5037 Nickel iron chromium molybdenum weldable heat resisting alloy sheets and strips (nickel base, Fe 36, Cr 18 Mo 5·25)

DTD 5047 Iron nickel chromium molybdenum weldable heat resisting alloy sheet and strip (iron base, Ni 43·5, Cr 16·5, Mo 3·25)

DTD 5057 Nickel chromium cobalt molybdenum weldable heat resisting alloy sheets and strips (nickel base, Cr 18, Co 14, Mo 7)

4) *Titanium Alloys*

DTD 5023 B Commercially pure titanium sheets and strips (tensile strength 30-40 ton/sq inch) (suitable for welding)

DTD 5033 B Commercially pure titanium sheets and strips (tensile strength not greater than 30 ton/sq inch) (suitable for welding)

5) *Copper Alloys*

DTD 283 A Aluminium nickel silicon brass sheets (annealed) (for sheets not over 24 inches web) (Amendment 1)

A-2. The ultimate tensile strengths of the materials given in **A-1** in the as welded condition and the angle of bend and radius of former for the bend test, as extracted from DGQA Inspection Instruction — Welding, Av P. 84 D. 505, Issue 1, are given in Table 2 for information.

APPENDIX B

(*Clause* 8.2.4.4)

RECOMMENDED METHOD OF PREPARING ETCHED SPECIMENS

B-1. PROCEDURE

B-1.1 The following method of preparing etched specimens is suggested for convenience and in no way intended to be a rigid requirement of this standard.

B-1.1.1 *Preparation of Surface for Etching* — The surface should be filled with a coarse file until all deep marks are removed. It should then be filed at right angles to the original coarse file marks with a smooth file. The smooth filed surface should be polished with successively finer grades of emery paper, 'M', 'F', '0', '00', and '000', the direction of polishing being at right angles to the marks made by the previous paper in each case. Polishing should be continued until the scratches of the previous paper have been removed before proceeding to the next finer grade. This procedure is indicated in order to show the means by which a first class finish may be obtained.

B-1.1.2 After polishing with emery paper of grade '000' the specimen is rinsed in water and then held against a rapidly rotating disc covered

with a suitable pad impregnated with a polishing powder. A suitable polishing medium for general use is a specially prepared form of alumina. A plentiful of water and polishing medium is used and the disc is rotated and fed with water while the specimen is held against the surface.

B-1.1.3 The specimen is examined for the presence of inter-granular oxide films and then etched with a suitable etching solution (Table 3).

B-1.1.4 The etching is carried out either by swabbing the surface with cotton wool or by immersing the specimen in the etching solution until the desired definition of structure is obtained.

B-1.1.5 The specimen should then be washed in distilled water, followed by rinsing with acetone or alcohol and quickly dried in a current of a clean air blast.

TABLE 3 ETCHING REAGENTS

(*Clause* B-1.1.3)

MATERIAL	ETCHING REAGENT	
Aluminium alloys	Nitric acid, conc	10 percent by volume
	Hydrofluoric acid (40 percent)	2 percent by volume
	Distilled water	88 percent by volume
Magnesium alloys	Nitric acid, conc	2 percent by volume
	Ethyl alcohol (industrial spirit grade)	98 percent by volume
Carbon steels and alloy steels	1) Picric acid	4 g
	Ethyl alcohol	100 g
	2) Nitric acid, conc	2 percent by volume
	Ethyl alcohol	98 percent by volume
Nickel alloys, brass or corrosion resisting steels	1) Ferric chloride	5 g
	Hydrochloric acid, conc	50 ml
	Distilled water	100 ml
	2) Oxalic acid	10 g
	Distilled water	90 ml
Titanium	1) Nitric acid, conc	19 percent by volume
	Hydrofluoric acid	1 percent by volume
	Distilled water	80 percent by volume
	2) Hydrofluoric acid (40 percent)	2 percent by volume
	Oxalic acid	98 percent by volume
Copper base alloys	Ferric chloride	5 g
	Hydrochloric acid, conc	50 ml
	Distilled water	100 ml

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816-1969	Use of metal arc welding for general construction in mild steel (*first revision*)	8·00
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823-1964	Code of procedure for manual metal arc welding of mild steel	11·00
1024-1968	Use of welding in bridges and structures subject to dynamic loading	6·50
1261-1959	Seam welding in mild steel	2·50
1323-1966	Oxy-acetylene welding for structural work in mild steel (*revised*)	4·00
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5206-1969	Corrosion-resisting chromium and chromium-nickel steel covered electrodes for manual metal arc welding	8·00
5530-1969	Code of procedure for repair and rectification of steel castings by metal arc welding process	7·50
Electrodes, Filler Rods and Wires		
*814-1970	Covered electrodes for meta arc welding of structural steels (*third revision*)	—
815-1966	Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel (*revised*)	5·50
1278-1967	Filler rods and wires for gas welding (*first revision*)	7·50
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1393-1961	Code of practice for training and testing of oxy-acetylene welders	10·00
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818-1968	Code of practice for safety and health requirements in electric and gas welding and cutting operations (*first revision*)	11·50
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3016-1965	Code of practice for fire precautions in welding and cutting operations	3·00

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TO

IS : 5922-1970 QUALIFYING TESTS FOR WELDERS ENGAGED IN AIRCRAFT WELDING

Alteration

(*Page* 7, *clause* **7.2.2.1**) — Delete the clause.

(SMDC 14)

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